810 Vegetation Restoration

General

The guidelines in this chapter provide background for the development of effective vegetation restoration methodologies. Two basic restoration approaches are used: managed succession and accelerated climax community development[1]. They are based on the principles of plant succession in natural ecosystems. The decision on which approach to use depends on permitting requirements, project goals, and roadside functional objectives. The Landscape Architect shall be involved in all discussions concerning these decisions.

The following table gives a general indication of when the two methods are used.

RCP Treatment Level	Managed Succession	Accelerated Climax Community Development
1	X	
2	X	X
3		X

Figure 810.1 Restoration Method Use

When roadside areas are disturbed during roadway projects, the project's lead agency or Project Office is responsible for rehabilitating the roadside according to the policies stated in the *Roadside Classification Plan*. The guidelines and discussion in this chapter will facilitate restoration of the roadside environment.

The use of native plants in roadside restoration will, over the long-term, reduce maintenance and life cycle costs of our roadsides. For example, the use of native plant communities reduces mowing costs over the life of the roadside.

References

Roadside Classification Plan, M 25-31, WSDOT

[1] Not all experts accept the Climax concept, however it is the most widely accepted theory of plant community development at this time. Because of its ease of use as a conceptual framework it will be used in this manual.

Resources

Region's Landscape Architects

Roadside & Site Development Unit

Region's Environmental Office

OSC Environmental Affairs Office Biology Unit

OSC Horticulturist

Definitions

accelerated climax plant community The process of restoring a site to a desirable climax plant community in reduced time when compared to natural processes.

allogenic succession Changes in the composition of the plant community as a result of environmental forces. [2]

autogenic succession Changes in the composition of a plant community due to interplant interactions (facilitation or competition).[3]

climax vegetation A stable end-point to plant succession ("steady state") where a group of species predominates and replaces itself.[4]

enhancement Any improvement of a structural component to increase the level of ecological functioning of a site.

genotype The genetic make-up of an organism.

managed succession A technique that uses management activities to modify the rate and direction of succession.

plant association A particular, consistent group of species growing in a particular, consistent type of habitat.

plant community A general term describing the group of plants growing in an area.

plant succession Directional, cumulative change in the species that occupy a given area through time.[5]

reference site An established, minimally disturbed natural site that is used as a comparative design guide to help determine the desired plant composition and species densities for the created or enhanced project site. Preferably, the reference site is near the project site, within the same watershed, and has similar hydrology, soils, solar

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[2] Oliver and Larson, p. 29.
[3] Ibid., p. 29.
[4] Ibid., p. 147.

exposure and aspect, and topography. Multiple reference sites can be used resulting in a number of possible community outcomes.

restoration The process of renewing and returning ecosystem function and health[5] (for systems that have been significantly altered by human activity).

Succession

Plant communities are in a constant state of fluctuation due to changes in their environment. As a general rule, the composition of any given community can shift in response to changing conditions caused by disturbances. If the disturbance is small, the change in plant community will not be dramatic. If the disturbance is large, such as fire, a landslide, or road building activities, the change in the plant community will be dramatic. Species most suited to the new conditions will colonize in the greatest number. Over time, if no new disturbance occurs, new plants will colonize the area. The new species often tend to be larger, longer lived, and/or woody. This directional, cumulative change in the species present over time is plant succession.

Succession is governed by both external and internal forces. Allogenic (external) forces include human activity, animals, fire, wind, flooding, earthquakes, land slides, climate change, and pathogens and pests.

Autogenic (internal) forces include competition or facilitation between the plants themselves that bring changes in relative abundance of species. These internal changes include displacement of one species by another, shifts in population structure (relative percentage of any one species to the population as a whole), facilitation of increasing dominance by one species due to the conditions created by another, and changes in available resources (sunlight, soil, moisture, etc.).

Disturbance and Succession

Depending on the severity of a disturbance, two types of succession can take place. These are primary and secondary succession.

Primary succession is the initial stage of plant community restoration following a severe disturbance that leaves bare soil. Initial colonizers, known as pioneer species, establish themselves rapidly during the first growing season, providing cover and minimizing soil erosion. Many plants involved in primary succession are those that can tolerate a wide variety of conditions including the scarcity of water

[5] Society for Ecological Restoration, 1995.

and nutrients. They reproduce rapidly and often spread large quantities of seed using wind or animals as carriers; characteristics of many weeds; for example Scotch broom in uplands or toad rush in a wetland.

Secondary succession begins either after the plant community of the primary successional phase has become established or following a more mild disturbance which leaves some of the predisturbance habitat in tact. Plants involved in secondary succession are generally longer lived and require somewhat more developed soil conditions to survive. They are often fast-growing trees or shrubs and serve to further stabilize and amend the soil. Examples of secondary succession include red alder colonizing a clear-cut, willow spreading into or along the edge of a wetland, or Douglas fir getting started in a windfall-caused clearing in a mature western hemlock forest.

Secondary succession can take place without the entire plant community being dominated by the new species. A single new species out competing an established species for its niche habitat is an example of secondary autogenic succession.

Climax Plant Communities

As conditions change across varying habitats, the plant community that dominates the area changes. Communities also change over time as plants and animals alter the microenvironment by changing the nutrient content, texture, and moisture levels in the soil. Their physical structures also provide shade and intercept rainfall, affecting the microhabitats within their canopies. These changes, coupled with disturbances, give other species a competitive advantage.

Over a long period of time, a series of subtly different communities dominate the site. Eventually, in the absence of disturbance, a steady state is reached in which existing species keep reproducing their numbers and new species are mostly excluded. This later example is known as a climax community and represents a mature, stable system. Even climax communities can be sent back to an earlier successional stage by disturbances such as fire or beaver activity.

Genetic Diversity

One goal in vegetation restoration is to match the genotype of plant materials as closely as possible to that which occurs in similar plant associations within the watershed.. Unlike agriculture or forestry, which selects genetic strains for a limited number of desirable characteristics (such as a crop ripening at the same time for ease of harvest), restoration seeks to promote and retain the natural range of variation of genotypes that occur within in nearby reference sites.

Genetic diversity often allows for wide variability within the same species in a single plant community.

Appearance does not necessarily indicate the genetic adaptability of a plant. One member of a species might have characteristics that allow it to survive under stresses such as drought or pests. All members of the community can be of value.

Members of the same species found in different locations have different adaptations to their specific differences in habitats (for example soil type) or climate (for example blooming times might vary in accordance with local rainfall patterns). It is desirable to obtain plants grown from seeds or cuttings taken from within the same watershed whenever possible because these small differences can affect plant survival.

Vegetation Restoration Concepts

Managed Succession

With the strategy of managed succession, the objective usually is to manipulate the introduction of native pioneer species to develop site conditions that are conducive to desirable climax, or later successional species. This method is less expensive than planting an accelerated climax plant community and utilizes the desirable quality of promoting natural processes.

There are often situations where a later successional community might not be desirable. Managing successional patterns (arresting succession at a stable shrub stage for example) through careful design, site preparation, and selective maintenance is appropriate and desirable in many situations.

Management of the site might include introduction of pioneer species and secondary successional species or it might allow pioneer species to come in on their own. Periodic removal of the pioneer species and gradual introduction or encouragement of climax or later successional species might also be necessary. We expect our “mature” sites to go through some successional changes.

Pioneer or primary successional species are often weedy grasses and forbs that can rapidly colonize large patches of bare ground.

Eastern Washington

In much of Washington east of the Cascade mountains, grasslands with forbs are often the climax species. Woody vegetation might be limited or nonexistent.

In grassland and prairie restoration, develop a seed mix of native grasses. See the Appendix for grass seed mixes for low moisture zones.

- The species chosen are dependent upon the site and precipitation amounts. Use reference sites and local native ecosystem associations a guide.
- Growing contracts for grasses might require 2 years lead time to produce sufficient seed for WSDOT construction or restoration projects.
- Select a mixture that allows for quick erosion control and long term soil structure enhancement.
- Add appropriate forbs to the seed mix for nitrogen fixing, nectar sources, and visual enhancement where wildlife forage will not contribute to a road-kill problem.
- Consider drill seeding native grasses. This gives the seed needed soil contact and protects the seed from wind and sun.
- Native grasses develop their root system before they develop top growth. Top growth might not be visible until the second or third year. Don’t give up.
- Before using fertilizers in native grassland restoration, analyze the site and its soil chemistry. Native grasses cannot use large flushes of nutrients. When fertilizers are necessary, use a slow-release form.

Woody vegetation might consist of a sagebrush community, or trees that grow only on north-facing slopes or in riparian zones.

- Where it is practical and desirable to grow woody species, select plants that have been grown locally, whenever possible, because these will be hardy in that climate.
- If fertilization is needed, use only slow-release granular fertilizer.
- Some species in Eastern Washington can be considered pioneer as well as climax species. Quaking aspen, lodgepole pine, water birch, and Ponderosa pine are examples.

Lowland Western Washington

Woody secondary successional species begin to dominate once the primary pioneers have thoroughly colonized and “improved” the site conditions. Suitable early successional plants for humid ecosystems in Washington are Douglas fir, black cottonwood, willows, red alder, bigleaf maple, paper birch (Snohomish County and north), Oregon ash (southern King County and south) and red osier dogwood. These plants essentially function as a cover crop and are also part of a mature forest.

It is desirable that the species selection be proportioned to represent the natural, early succession stages or representative plant communities occurring in the watershed or sub-basin. Refer to chapter 800 for an example of this calculation.

Accelerated Climax Plant Community Development

The objective is to restore a site to a desirable climax plant community, or "special" non-climax communities: such as Puget prairies & sedge meadow wetlands, in reduced time when compared to the natural process. This method is more expensive than managed succession, but can meet project goals and regulatory requirements. Desirable conditions can be reached within 3 to 5 years.

The process involves the introduction of representative species of the desired plant community. Management of the site includes initial control or removal of undesirable plants.

Understory species might be selectively introduced over time. Species are selected from the referenced native plant community. The plant selection is generally a simplified representation of the desired climax plant community.

Plant selection criteria include:

- *Roadside Classification Plan* treatment recommendations
- Native plant community
- Compatibility with site conditions
- Availability from commercial nursery sources
- Survival characteristics
- Functions to be provided by the plants
- Similar reference plant communities in the watershed or sub-basin

Factors limiting climax community development include the growth rate of the desirable species, development of upper soil horizons, and colonization by necessary insect, mycorrhizae, and animals.

Methods for Managing Succession

Working *with* succession can assist the roadside manager to develop sustainable plant communities that require minimal ongoing management.

Management activities modify the rate and direction of succession. A management plan can be designed to either promote or hold succession at a given stage.

The three components of managed succession are:

- Designed disturbance
- Controlled colonization
- Controlled species performance

These are detailed further on succeeding pages. Each of these components can be used to enhance or arrest succession along the roadside. Note: arresting succession requires ongoing maintenance. (For example, mowing or burning to maintain open grassland rather than Scotch broom or forest.)

Examples of possible components of managed succession follow.

- Plant (or allow colonization by) desirable early successional species such as red alder or bigleaf maple (controlled colonization).
- Thinning of these trees can be done once they grow large enough to provide shade (designed disturbance).
- Interplant shade tolerant trees, such as western red cedar or western hemlock, or understory shrubs, such as salal or huckleberry (controlled colonization).
- Soil can be amended to optimize growing conditions for desired species (controlled species performance).

The overall goal of using managed succession is to establish sustainable plant communities.

Sustainable plant communities meet *Roadside Classification Plan* goals with minimal maintenance force expenditures.

Designed Disturbance

Designed disturbance is any activity initiated to create or eliminate site availability for plant growth. Examples of designed disturbance activities include, but are not limited to:

- Burning
- Chopping
- Clearing
- Fertilizer application
- Herbicide application
- Mowing

- Soil pH manipulation
- Thinning
- Adding topsoil and mulch

Along with climate, elevation, surface and ground water attributes, and orientation factors, soils are a primary determinant of vegetation patterns. Of these four factors, soils are most easily manipulated at any given location by the addition of amendments, nutrients, cultivation, grading, and water. It is important to replicate the natural soils on which the desired plant community is typically found.

The soil requirements of different plant communities can be drastically different with regard to pH, organic content, moisture levels, and chemical composition. Be sure the plants being installed either are adapted to the soil conditions of the site or that the resources are available to change the soil conditions. See the Soil and Soil Amendments chapter in Division 7 of this manual for more information.

Controlled Colonization

Controlled colonization usually involves adding plants to a site. Planting could range from seeding to planting large plants. In addition to introduced plants, desirable existing plants or seeds might be present on-site, or might be able to spread from adjacent sites. These plant starts will compete with, or augment, the ultimate design plant community. *Caution*: The introduction of exotic plants can seriously undermine vegetation restoration efforts. Every effort should be made to keep particularly troublesome species (for example reed canarygrass or Scotch broom) from becoming established at the site. Seed mixes, plantings and imported soils, should be guaranteed to be free of seeds, rhizomes, etc.

Controlled Species Performance

Controlled species performance uses various methods to decrease or enhance growth and reproduction of specific plant species. Successful controlled species performance recognizes the dynamic character of plant communities, and encourages specific plant communities that will resist invasion through competitive interactions. Individual species and their populations are targeted within this context. To accomplish this, the manager must have knowledge of species characteristics, including:

- Water, light, and nutrient requirements.
- Physiological characteristics, such as root structure, or plant shape.

- Responses to competition.
- Role within the plant community and successional pathway.
- How each species responds to proposed management techniques.

By understanding and using this information, the roadside manager can use common practices to control species performance. Some examples of controlled species performance practices are:

- Mowing undesirable species after flowering but before seed production to eliminate reproduction.
- Not mowing where desirable species (such as lupine) exist until after seed production to allow for next year's stand.
- Shading out shade intolerant invasive species with tree or shrub cover. (Not all invasive species are shade-intolerant, however.)
- Plant-specific application of selected herbicide.

Evaluation

To be successful, evaluate managed succession techniques until goals and objectives stated in the management plan are met, regulatory commitments are met, and the site is functioning. If a plant community is not developing according to the design set in the management plan, the region's maintenance staff, with the landscape architecture office, the Biologist, and the OSC Horticulturist will evaluate the situation and adjust practices and/or management plan goals accordingly.

Contracts and Schedules

Growing Contracts

Because plants selected from genetic stock obtained from the same habitat as the project adapt better to those climatic conditions, growing contracts may be necessary to obtain sufficient numbers of desired plants. For woody vegetation, one to two years growing time may be necessary. Grass and forbs may require two years or more from seed collection to seed production in numbers sufficient to seed the project area.

Consider having vegetation grown from seeds or cuttings taken from the vegetation of the construction site before construction begins.

When practical, allow time in the landscape contract for growing contracts where insufficient stock is available. This is in addition to the 1 to 3 year plant survival clause in the landscape contract.

Landscape Contracts

Because of the specialized nature and timing of roadside revegetation and restoration work, it can be advisable to separate this part of the contract from the engineering component of the project. This can allow the engineering contract to close while the revegetation contract continues. Funding must be assured in advance.

Consider work sequencing over at least two seasons to allow for managed succession practices.

Consider adding minimum landscape contractor's qualifications and references to the contract. Contract inspectors shall include the restoration design team or the wetland design team to ensure the project is constructed as designed, that it will meet regulatory requirements, and to make necessary adjustments to meet unexpected soil or moisture conditions.

For grassland work, consider specifying no-till seed drilling for seeding without disturbing the soil layers. This can be done only where the existing vegetation has been eradicated using non-residual herbicides.

Construction Scheduling

Planting must be done during planting windows, per the *Standard Specifications* to allow for maximum growth during the rainy season.

Woody Vegetation

Plant stock one gallon or smaller in size, and consider using polymers in the soil or supplement with other water-holding polymers during the first summer. Continue to monitor plants during the first 3 to 5 years to determine plant moisture needs and supplement as practical and necessary.

Grasses and Forbs

The ideal seeding window is specified in the *Standard Specifications* to take advantage of seasonal rainfall.

It is possible that native grasses will not be visible the first year because they develop their root systems first before putting out top growth. A provision for initial erosion control must be made while the native vegetation becomes established. This can take the form of erosion control matting or a cover crop such as sterile wheat.

Plant Establishment Maintenance and Monitoring

Maintenance of new plantings until they become established is critical to the success of revegetation projects. Landscape contracts must include provision for plant establishment and maintenance.

Plant Selection Including Plant Establishment (PSIPE) should be enforced in all contracts. Under this provision, the contractor maintains and guarantees plant survival for the first 1-3 years depending on the contract.

Allow funds for maintenance of the site until desirable plants become fully competitive with weeds (generally 3 to 5 years). Maintenance can include planting additional plants to meet coverage requirements. The Landscape Architect can arrange for contractors such as the Washington Conservation Corps or corrections crews to perform this maintenance. These provisions allow WSDOT to meet required standards of success in restoration permitting and to restore roadside functions after roadway construction.

Consider the following techniques:

- Selective weeding.
- Wicking with herbicides, or other selective herbicide treatments, where appropriate.
- Native prairies need regular disturbance in the form of mowing or fire to prevent invasion by woody species. Controlled burns might be done in coordination with local fire department training. Burn no more than 1/3 to ½ of the prairie acreage per year. This allows a refuge for insects (such as butterflies) to survive the disturbance.
- For prairie restorations, high mowing (6-12 inches) can be done once late winter/early spring growth starts - this can be as early as January in lowland Western Washington and again before seeds mature. Mowing during this time will encourage natives and cut back the nonnative species by removing the leaves, flowers, and immature seeds of fast-growing non-natives.

Monitor native prairie vegetation during the growing season. Native forbs and grasses go dormant during the dry season (July through September). Monitoring during this season will not provide complete plant community data.

Additional Sources of Information

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